FILE COPY FOREST INSECT LABORATORY, STANFORD UNIVERSITY CALIFORNIA.

485.C+
464.3

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PLANT INDUSTRY

OFFICE OF FOREST PATHOLOGY

Title: DEGRADE FROM BLUESTAIN AND OTHER FUNGI IN INSECT-ATTACKED WESTERN YELLOW PINE, MODOC NATIONAL FOREST.

Author: Willis W. Wagener.

A Report to the
District Forester, D5.

To _____

From _____

For information

For criticism

To be published in _____

Please forward to _____

Date April 7, 1930.

U. S. GOVERNMENT PRINTING OFFICE: 1928 J97458

April 7, 1930.

DEGRADE FROM BLUESTAIN AND OTHER FUNGI IN INSECT-ATTACKED WESTERN YELLOW PINE, MODOC NATIONAL FOREST

A Report to the
District Forester, D5.

The study reported on herein was undertaken in order to secure more definite information on the development of bluestain and other fungi in western yellow pine following bark beetle attack, particularly in the pine stands of northeastern California and southern Oregon. In this territory epidemic infestation by the western pine beetle, Dendroctonus brevicomis, has caused heavy losses in recent years and it was hoped that a portion of the loss might be averted through the salvage of the attacked timber.

Boyce[1] in 1922 made a study of the progress of cull in felled trunks of beetle-attacked western yellow pine from which the bark had been peeled and the latter burned. He found that cull, aside from bluestain, averaged 18% by the end of the first year after treatment. This was mainly due to checks but in one tree sap rot was a culling factor. All of the sapwood with the exception of the dry outer layer was found to be heavily bluestained by the end of the first season.

As Boyce's investigation did not extend to standing, beetle-attacked timber observations on trees of this type were begun by the writer in the fall of 1928 near Brown's Well, Modoc National Forest, in connection with beetle treating operations by the Pickering Lumber Company. Preliminary results, based on observations on a small number of freshly peeled trees were reported in a brief memorandum to the District Forester on November 2, 1928.

In January 1929 further work on the study was undertaken in connection with insect control operations of the Pickering Company on the Badger unit of the Modoc. The Company at this time was cutting western yellow pines infested by the western pine beetle and skidding the trees in to a small mill. Here they were bucked into logs which were sawed into ties and rough construction lumber. Slabs, edgings and all loose bark were burned. In addition to the infested trees a considerable number of the better snags resulting from earlier bark beetle attacks were cut.

As in the case of the preliminary observations in the fall the Office of Forest Insect Investigations, Bureau of Entomology, cooperated in an advisory capacity on entomological

---

1 Boyce, J. S. The Deterioration of Felled Western Yellow Pine on Insect-Control Projects.
U. S. Dept. Agr. Bull. 1140 1923.

---

phases of the study. The assistance of Mr. F. P. Keen of that office is acknowledged in particular. Field work on the project was greatly facilitated through the hearty cooperation and assistance of representatives of the Pickering Lumber Company.

METHOD OF STUDY

The general plan of the study was to select trees attacked by bark beetles at various times of the year, mark the individual logs so they could be identified on the mill rollway and to observe the amount and distribution of bluestain or other sources of degrade and cull as the logs were opened up by the saw.

No trees were available for which the date of attack by the beetles was definitely known. However it was the opinion of Mr. Miller and Mr. Keen of the Bureau of Entomology that in nearly every case the date could be fixed to within a few weeks by making use of various indicators remaining on the trees. This seemed close enough for the purposes of the study.

It should be kept in mind in this connection that the date of attack for any given tree is not always clear cut. Attacks by summer broods under epidemic conditions cover practically the entire bole within a few days and a single date for the attack can be assigned without difficulty. Late fall attacks on the other hand are often confined to only a portion of the bole of the tree and are not extended to the rest of the trunk until the following spring. Early fall and late spring attacks

grade in between those of summer and late fall in the length of time elapsing between the initiation and completion of the attack. In trees with winter broods the mountain pine beetle (D.monticolae) may initiate or participate in the attack at the base or in the top of the tree. Trees attacked in the upper bole during the late fall are extremely hard to spot and are ordinarily not recognized as "bug" trees until the following spring.

As it was impracticable for Mr. Keen or other representatives of the Bureau of Entomology to be present for the field work of the study the assistance of Mr. Ernest Buck of the Pickering Lumber Company was secured through the cooperation of the Company for expert advice on the selection of trees according to probable date of attack.

It was decided to limit the study to trees which had been dead for not more than a year but within this limit to secure as full a representation in dates of attack as possible. Selections were made while the trees were still standing or after felling but before limbing or bucking. Brief notes were taken on each of the trees numbered and after bucking the logs were numbered so that they could be identified at the mill as to tree and position within the tree.

Average diameter at the small end and average width of sap for each log were taken on the mill rollway. Bluestain and other fungus deterioration in the sapwood were estimated

ocularly as the logs were sawed and recorded in per cents of total sapwood for the log, separate estimates being made for heavy (heavily colored) bluestain, light (lightly colored) bluestain, and sap rot. A yellow stain commonly present was estimated in degrees expressed by x approximately as follows:

(x)	= trace
x	= under 2% of sapwood stained
xx	= 2% - 40% " " "
xxx	= over 40% " " "

No attempt was made to differentiate intensity of the yellow stain as differences were hard to recognize. Diagram sketches showing the approximate distribution of the heavy type of bluestain were made from a considerable number of the logs. Supplemental notes on distribution of stain were also taken where necessary. Stain percentages were always based on the total sapwood of the entire log even though all of the stain might be concentrated at one end.

As a check on the accuracy of ocular percentage estimates the stained areas on a few sample boards were measured by means of a celluloid sheet ruled off in inch squares. This was laid down progressively over the surface of the board and the number of square inches occupied by stain was recorded, the total then being converted into percentage of the area of the board. From the results of these check measurements it is

believed that the percentage estimates for heavy stain and sap rot are reasonably accurate.

The same cannot be said for the percentage estimates of light bluestain. The latter is hard to judge in good light and in artificial light or the poor daylight which often prevailed during the study it was almost impossible to judge the amount present with any accuracy.

Temperatures were low enough to inhibit stain development during the two weeks required to complete the observations. No error reducing the value of the stain percentages for comparative purposes was thus involved.

Field notes on the trees were later checked over by Keen and at his suggestion a division into five groups, segregated according to time of attack, was made as follows:

Group	Attack by	Time of Attack	Color of foliage
A	(D. monticolae (D. brevicomis	Sept.-Nov. 1927 Oct.-Nov. 1927 & Apr.-May 1928	Reddish
B	D. brevicomis	June 1-July 15, 1928	Yellow
C	" "	July 15-Aug.15, 1928	Fading or Sorrel
D	" "	Aug.15-Sept. 1928	Green or partly fading
E	(D. monticolae (D. brevicomis	Sept.-Nov. 1928) Oct.-Nov. 1928)	Green

One tree included in the study appeared to antedate Group A slightly, the attack by D. brevicomis having probably occurred in August or September 1927. A separate designation, Group AA, was made for this tree. While attack dates for D. monticolae are given for groups A and E most of the trees of the study falling in these groups did not actually show any evidence that the mountain pine beetle had participated in the attack.

The trees belonging to groups A, D and E are known to entomologists as overwintering trees as the broods remain in the bark until the following spring.

RESULTS OF STUDY

Bluestain.

As has been indicated, bluestain occurred in two rather distinct grades of density, one deeply colored and sharply defined, the other a diffuse type of stain often so light in color as to be scarcely visible and with indefinite limits. From an identification furnished by Dr. Richards of our Madison Laboratory Branch it appears likely that the dense stain is in large part due to the fungus Ceratostomella pini. The cause of the light, indefinite stain has not been determined.

The dense or heavy stain appears to originate from the bark beetle galleries and becomes noticeable within one to three weeks after the tree is attacked. During the early stages of its development it shows on the surface of the sapwood when

the bark is removed as narrow, scattered dark streaks from one to several inches long. Radial penetration is relatively rapid, proceeding in almost straight lines along the medullary rays in the early stages but as the inner sapwood is reached the stained area usually expands so that in cross section it has the form of a horn or fustrum of a Neiloid. In consequence boards sawed through the inner sap show more stain than the slabs. In trees which have been dead for some months the difference in amount of stain present in the inner as compared with the outer sapwood is often very marked. In an occasional tree however there is a band of very wet inner sapwood through which the stain does not penetrate. These bands of wet wood show particularly well in a frozen state. The bluestain in such trees is confined to the outer layer of drier sap.

The light diffuse type of stain apparently develops more slowly and after the wood has dried out to some extent.

A concentration of heavy stain was commonly found in the sapwood at the base of the tree, extending up through the lower third or half of the butt log. A less marked and less uniform concentration was frequent in the upper bole in trees of Groups A, B and C, apparently located just below the upper limit of primary beetle attack. It was not noted in trees of the recently attacked fall group. This area of concentrated stain did not always fall within the top log and since it extended over a few feet only and the wood above often showed

no stain its presence was not always reflected in the stain estimates for the log as a whole. The increased stain in the base of the tree appeared to be due to more favorable moisture conditions and in some trees to the presence of mountain pine beetle galleries. Keen has noted that a greater amount of stain seems to develop from the galleries of this species than from those of D. brevicomis.

Through the intermediate portion of the bole stain was found to be fairly uniform, occurring as scattered spots or narrow streaks in the summer and fall attacked trees. A characteristic pattern of stain distribution in logs from this portion of the bole is shown in Figure 1.

Considerable variation in the amount of stain present on different sides of a log was sometimes noted. An attempt was made to see whether this variation bore any relation to compass direction or to shade received by the standing tree but the data secured were insufficient to be of any assistance.

The average percentages of heavy and total bluestain for the various tree groups are shown in Table I.

Owing to the difficulty, already mentioned, in judging the amount of light, diffuse stain present, the figures for total stain, which include the light stain, are much less accurate than those for the heavy stain.

Very little light stain was found in the trees of

Fig. 1. Sap board before edging from third log of tree attacked in late summer showing amount and distribution of bluestain. (Group C, Tree 29, log 3).

Table I.

Per Cent of Bluestain in Sapwood.

Group	Time of Attack	No. Trees Basis	Per Cent Heavy Bluestain: Butt Log	Interm. Logs	Top Log	All Logs	Per Cent Total Bluestain (Light-heavy): Butt Log	Interm. Logs	Top Log	All Logs
AA	Aug.-Sept. 1927	1	85	95	90	90	85	95	90	90
A	+Apr-May 1928	15	37	11	10	17	55	30	27	35
B	June 1-July 15	24	17	9	16	13	29	24	27	26
C	July 16-Aug. 15	24	17	11	20	14	26	23	29	25
D	Aug. 16-Sept.	10	18	11	6	11	22	14	6	14
E	+ Oct.-Nov. 1928	7	2.4	0.6	0.4	1.0	8	0.8	0.4	2.8

\+ Also some attack at the base by Dendroctonus monticolae likely, September to November.

Groups D and E, attacked in the late summer and fall. What was found was confined to a few trees. The rest showed only the dense or heavy type of stain.

It will be seen from the table that, on the average, there was an appreciable amount of stain in all except the most recently attacked trees. The influence of the heavier concentrations of stain in the butt and top logs also shows up to

some extent in the average figures. They do not show the considerable differences in stain percentages found as between different trees in the same group. These are brought out in Table II, (a) and (b) which gives the dispersal of the trees included in the study according to percentage of sapwood stained.

It will be noted that the differences are quite wide, both in the heavy stain and in the total stain. In Group D 6 trees had 5% or less of the sap showing heavy stain while the remaining 4 trees showed 11% to 40% of heavy stain. These latter trees were attacked during the early part (August) of the period covered by the group when conditions for stain development are very favorable. The presence of over 6% of heavy stain in one tree of Group E is explainable in the same way. In this tree the first log contained an area of heavy stain at the butt, the second log showed a few recent beetle galleries but no stain and the remaining logs had not been attacked. It is likely that the attack at the butt was initiated prior to October 1 and that the tree therefore might rightly be classed in Group D. Omitting this tree the average percentages for heavy and total stain in the trees of Group E amount to only 0.4% and 0.6% respectively.

More detailed tables showing the percentages of heavy and total bluestain by trees and logs are given in the Appendix. The trees are arranged by D.B.H. within each group.

Table II.

Tabulation of Dispersal of Trees according to Individual Average Stain Percentages.

(a) Dense or Heavy Type Bluestain.

Average % stain for tree	Trees in Group. AA	A	B	C	D	E
Less than 2		1			4	6
2-5		3	5		2	
6-10		8	10	8		1
11-20		1	9	13	1	
21-30		1		1	2	
31-40			2	2	1	
41-50						
51-75		1				
76-100	1					
TOTAL	1	15	24	24	10	7

(b) Total Bluestain.

Average % stain for tree	Trees in Group. AA	A	B	C	D	E
Less than 2					2	6
2-5			2		2	
6-10			1	1	1	1
11-20		2	10	11	1	
21-30		4	5	8	3	
31-40		6	1	1		
41-50			3	1	1	
51-75		2	2	2		
76-100	1	1				
TOTAL	1	15	24	24	10	7

As an inspection will indicate, no correlation was found between diameter and percentage of bluestain present. It will also be noted that in Groups D and E there were several trees in which the upper logs had not been attacked by the beetles. The crowns of these trees were perfectly green and probably would have remained so until the following spring.

Although none were included in the study an occasional "dry" tree is found with very little bluestain or other fungus development. Such trees are usually thin-barked and on removal of the bark the wood is seen to be dry and checked, one or two major checks extending in practically to the pith. All indications point to a rapid drying out of the wood after attack, the drying evidently being fast enough to prevent all but a limited development of bluestain and associated fungi. Though the wood is almost all bright and sound its checked condition makes the utilization of such trees impracticable. Outside of the thin bark no unusual characters which might shed light on the cause for the rapid drying were noted.

Yellow Sap Stain.

A lemon yellow sap stain caused by an undetermined fungus was common in the trees attacked during the summer and earlier. It occurred as longitudinal streaks between blue-stained areas or in isolated streaks by itself and was more noticeable in the summer-killed trees, Groups B and C.

The numbers of trees in which yellow stain was present and those showing a moderate to extensive amount of the stain are given in the table below:

Table III.

Occurrence of
Yellow Sap Stain in Sapwood.

Group	AA	A	B	C	D	E	Total	% of Total Trees
Total trees in group	1	15	24	24	10	7	81	100
Total trees showing yellow stain	1	8	17	18	1	0	45	55
Trees with moderate to extensive yellow stain	0	4	6	8	0	0	18	22

The occurrence and distribution of the stain was quite irregular both in individual trunks and among the individual trees of a group. A green fungus macroscopically close to the green cheese molds was very common on the surface of the wood under the loosened bark of summer-killed trees and may be responsible for the yellow stain though the latter is by no means always found where the fungus is present.

So far as could be determined by field tests, the stained wood was not weakened and from the utilization standpoint may be regarded in the same class as bluestained wood.

Sap Rot.

That sap rot may gain considerable headway even within

the first year after attack is shown by the table below. Early or advance stages and the later stages of more pronounced rot are combined in the table because it was found impracticable to separate them in the study.

Table IV.

Occurrence of
Sap Rot in Sapwood.
(includes early stage or advance rot)

Group	AA	A	B	C	D	E	Total	% of Total Trees
Total trees in group	1	15	24	24	10	7	81	100
Total trees with sap rot	1	12	13	8	0	0	34	42
Trees with over 5% of sapwood with sap rot	0	5	3	0	0	0	8	10

Though the heaviest percentages of trees with sap rot are in the earlier groups, A and B, one-third of the late summer trees, Group C, also showed it. As with yellow stain the occurrence within a group was extremely irregular, some trees having a considerable amount, others none at all. In individual logs as high as 50% of the sapwood was involved while 24 logs from 12 different trees showed 10% or more of the sap decayed.

The rot appeared to be all of the same character and was probably due to one species of fungus. The identity of the latter was not determined. Had the study covered a wider area

other types of sap rot would no doubt have been found.

In the early stages the decay occurred as scattered streaks of slightly darkened wood, delimited along the margins by brownish zone lines. In the later development the wood had become somewhat spongy and brash but in the trees included in the study none of it had reached the disintegration stage. All was sufficiently firm to stand sawing and the handling in the yard without breaking, at least in the green state. In trees dead for more than a year decay would no doubt have progressed so far as to render part of the wood entirely unusable.

Once established the decay appears to develop rather rapidly from narrow, longitudinal streaks into irregular patches. The extension takes place along the surface of the sapwood, no doubt aided by the activities of secondary insects under the bark. From here it spreads somewhat more slowly and irregularly in toward the heartwood. In time the entire cross section of sapwood becomes involved.

Combined Fungus effects.

Nearly all of the trees which had been dead for any length of time contained either yellow stain or sap rot or both along with bluestain. The numbers of trees showing combination effects in the various groups are given in Table V.

Table V.

Combined incidence of stains and decay due to fungi.

Group	Period Attacked	Total Trees in Group	Trees With: Bluestain Yellow stain Sap rot	Bluestain: Sap rot	Bluestain Yellow stain	Bluestain only
AA	Early fall prev. yr.	1	1	-	-	-
A	Fall prev.yr. Spring curr. yr.	16	8	3	-	4
B	Early summer curr. yr.	24	11	2	6	5
C	Late summer curr. yr.	24	7	1	11	5
D	Early fall curr. yr.	10	-	-	1	9
E	Late fall curr. yr.	7	-	-	-	7

Trees or logs with high percentages of heavy bluestain did not at the same time show heavy sap rot or yellow stain. In fact in Group A the two trees with the highest percentages of bluestain contained no visible yellow stain or sap rot while the tree with the lowest percentage of heavy bluestain had next to the highest percentage of sap rot found in the group. This relation is to be expected from the well known phenomena of antagonism which most fungi exert toward one another when planted on the same substratum. Bluestain, being the first type of

fungus to gain a foothold in the sapwood of an attacked tree no doubt has some inhibiting effect on the establishment of other fungi in the area occupied by it. Therefore the chances for other fungi to become established should tend to be in an inverse ratio to the amount of bluestain present. Observations made during the study appear to bear out this assumption. It cannot be concluded however that bluestained wood is immune to attack by all fungi or that an inhibitory effect which may exist during the active life of the bluestain organisms is permanent.

All fungus action observed in the study logs was confined to the sapwood. The heartwood in every case was sound and bright.

Observations may be summarized as follows:

Overwintering trees of previous year, Group A.

Sapwood
All logs bluestained to some degree, 15-90% heavy stain in butt logs; considerable light diffuse bluestain throughout; moderate sap rot to be expected though absent in some trees; small amount yellow stain.

Heartwood
Sound and bright.

Main summer trees, Group B.

Sapwood
All logs with bluestain, concentration of heavy stain in butt and sometimes in top; rest of bole with 1-10% heavy bluestain in scattered streaks, 40-50% in occasional logs; moderate to high percentage light bluestain in all logs; some sap rot in about one-third of logs; pronounced yellow stain in some trees.

Heartwood
Sound and bright.

Late summer trees, Group C.

Sapwood
All logs with bluestain; much variation tree to tree in stain per cent; half of logs with 10% or less scattered heavy stain, one-eighth with over 25% heavy stain; occasional sap rot in early stage; yellow stain prevalent.

Heartwood
Sound and bright.

Early fall trees, overwintering or part overwintering, current year, Group D.

Sapwood
Some upper logs not attacked; bluestain variable in rest, mostly heavy type; one-fourth logs with over 20% heavy stain, stain in remaining logs mostly under 5%; no sap rot; no yellow stain.

Heartwood
Sound and bright.

Late fall overwintering trees, current year, Group E.

Sapwood
One-third logs bright, rest with scattering small streaks heavy bluestain 1% or less; occasional log with concentration heavy stain; no sap rot; no yellow stain.

Heartwood
Sound and bright.

DISCUSSION.

In considering the application of results it should be kept in mind that the numerical representation of trees in the various groups used in the study does not correspond to that ordinarily found in nature. Normally the main summer trees,

Group B, far outnumber the others and their condition would in large measure determine the salvage possibilities.

Moreover the observations are based only on winter cut trees. In trees cut at other seasons a different picture of fungus development would be obtained. Summer-attacked trees fade rather rapidly and become recognizable sooner than those attacked at other seasons but conditions at this season are also favorable for rapid fungus development. Hence some bluestain should be expected even though the trees are cut as soon as fading becomes noticeable.

Although the heartwood in all study trees was sound it makes up only about two-fifths of the log volume in the Modoc stands (39% in a 180-log sample of study logs) so that the sapwood condition is the dominating factor in considering salvage.

The study indicates that with the exception of occasional logs bluestain must be expected in insect-killed trees even though salvage is rapid. The stain percentage should not be high until after the bark has been loosened by the activities of secondary insects such as the round head borers, a matter of at least two or three months after the date of primary attack. Sap rot, which appears to be tied in more directly with the activity of the secondaries, is likely to be found in early stages any time after four months but does not ordinarily become serious until trees have been dead for a longer period, during

part of which warm weather has prevailed. Owing to the scattered occurrence of the initial infections they may be overlooked in the log, particularly since the wood in the early stages is firm and can scarcely be recognized except for the brownish discoloration. At least half of what has been called sap rot in the study was sufficiently firm so that no deduction would be made for it under present Forest Service scaling rules. It differs from the ordinary"red heart" of standing timber however in that development of the decay will continue after sawing if conditions are favorable whereas the fungus causing "red heart" ceases development soon after the tree is cut and does not revive. On this account early stages of sap rot offer more potential risk when converted into lumber than do the ordinary heart rots.

WILLIS W. WAGENER,
Pathologist.

Appendix.

Western Yellow Pine - Modoc.

Average per cent of bluestained sapwood by individual trees and logs, January 1929.

Group AA - Attack Aug. 15 - Sept. 30, 1927.

Tree No.	D.B.H.	Heavy Bluestain - % by Logs						Total Bluestain - % by Logs					
		1	2	3	4	5	6	1	2	3	4	5	6
45	30	85	95	90				85	95	90			

Group A - Attack Oct., Nov. 1927 - Apr., May 1928.

Tree No.	D.B.H.	Heavy Bluestain - % by Logs						Total Bluestain - % by Logs					
		1	2	3	4	5	6	1	2	3	4	5	6
43	18	25	4	8				55	29	8			
63	20	35	3	2				60	38	22			
40	22	65	10	6	5			90	80	31	75		
									?)				
8	24	70	20	5				80	20)	15			
										?)			
24	24	30	4	6	10			40	14	6)	10		
25	26 ?	30	3	2	6			40	43	27	21		
26	26	45	4	4	2			75	24	19	17		
7	28	35	8	6	18			40	13	9	28		
41	28	30	4	2	5			50	19	12	20		
42	28	15	5	6	6	35		35	30	16	16	35	
69	28	90	75	65	25			100	90	65	50		
23	30	20	8	4	2			50	68	54	42		
49	30	25	8	8	12	30		50	33	23	27	50	
18	34	30	15	12	4			45	30	18	8		
17	38	6	3	3	1	1		18	18	11	7	6	

Group B - Attack June 1 - July 15, 1928.

Tree No.	D.B.H.	Heavy Bluestain - % by Logs						Total Bluestain - % by Logs					
		1	2	3	4	5	6	1	2	3	4	5	6
52	20	20	5	6				35	15	6			
22	22	8	1	2				15	1	7			
34	22	6	1	1	8			6	1	1	8		
46	22	18	2	2				23	12	2			
48	22	14	2	4	3			34	14	14	18		
51	22	25	2	3	6			40	32	18	26		
54	22	15	4	4				20	14	14			
53	24	12	4	4	3			32	29	24	23		
12	26	4	3	6	50			4	8	10	50		
14	26	10	8	6	40			10	11	11	40		
58	26	20	1	8	12			20	16	8	32		
9	28	5	1	1	1			6	1	1	1		
21	28	30	25	40	40	50		35	30	45	45	50	
44	28	20	8	8	10			30	23	48	10		
47	28	18	3	2				33	23	22			
67	32	30	20	5	8	5		80	50	65	48	20	
6	34	30	10	10	10	x		40	20	13	10	x	
13	36	20	25	40	50	40		25	35	60	50	55	
35	36	12	1	2	3	40		12	1	2	3	40	
55	36	20	10	8				50	70	48		?)	
65	36	45	3	4	5	5	15	85	63	64	55	5)	20
10	38	2	8	20	40			22	13	35	80		
28	38	15	4	3	10			25	10	18	15		
20	40	2	3	8	15			6	8	20	20		

x = Log missed at mill.

Group C - Attack July 15 - Aug. 15, 1928.

Tree No.	D.B.H.	Heavy Bluestain - % by Logs						Total Bluestain - % by Logs					
		1	2	3	4	5	6	1	2	3	4	5	6
11	20	6	3	15				8	3	15			
62	20	15	5	10				15	20	30			
37	22	30	1	6				35	11	14			
39	22	18	20	8				18	20	8			
64	22	12	18	2	8			12	28	52	18		
50	24	15	3	4	5			15	13	29	13		
32	26	8	20	12	0			8	30	12	0		
33	28	35	10	8	20			50	15	8	20		
68	28	5	10	4	16			10	10	14	26		
15	30	25	10	10	8	15	20	35	18	15	13	15	20
29	30	10	8	8	20			30	18	20	35		
31	30	3	10	10	35			18	20	10	35		
38	30	40	2	3	25			45	6	3	35		
56	32	12	1	3	4	50		12	1	13	24	70	
19	34	40	50	30	25			55	50	30	25		
36	34	15	3	3	25			25	18	13	25		
16	36	15	2	2	2	6	40	20	6	6	7	10	40
27	36	10	4	10	40	15	12	20	14	16	40	15	12
30	36	25	10	12	35	15		25	10	12	50	15	
57	36	25	25	15	15	30		85	85	65	65	70	
59	36	16	40	55				16	40	75			
60	38	4	1	1	6	25		9	31	21	6	25	
61	38	10	2	2	5	18	10	35	2	2	5	18	10
66	40	16	15	8	20	12		21	30	78	80	62	

Group D - Attack Aug. 15 - Sept. 30, 1928.

Tree No.	D.B.H.	Heavy Bluestain - % by Logs						Total Bluestain - % by Logs					
		1	2	3	4	5	6	1	2	3	4	5	6
81	22	12	30	20	0.5			12	30	25	1		
75	26	0.8	3	1	1			0.8	3	1	1		
79	26	30	35	20	25	25		30	35	20	25	25	
73	28	10	4	0	-	-		20	6	0	-	-	
74	30	0.2	0.5	1	-	-	-	0.2	0.5	1	-	-	-
71	34	1	0.8	3	3	0.3		1.5	0.8	6	3	0.3	
77	34	60	30	20	2	4		70	30	20	2	4	
4	36	x	x	2	5	x	x	x	x	22	25	x	x
78	38	0.7	2	3	0.5	-	-	1.2	4	6	0.5	-	-
80	44	45	x	x	x	20	-	65	x	x	x	20	-

Group E - Attack Oct. 1 - Nov. 1928.

Tree No.	D.B.H.	Heavy Bluestain - % by Logs						Total Bluestain - % by Logs					
		1	2	3	4	5	6	1	2	3	4	5	6
2	20	0.5	1	0				1	1	0			
1	22	0	0.5	0.5	1			1	1.5	0.5	1		
3	30	T	0	1	0.5			T	0	1	0.5		
5	30	0.2	0.5	0	T			0.2	0.5	0	T		
70	30	0.4	0.5	0.5	1	-	-	0.6	0.5	0.5	1	-	-
76	38	1	0.5	0	-	-		2	0.5	0	-	-	
72	42	15	0	-	-	-	-	55	0	-	-	-	-

Symbols:- T = trace
- = Log not attacked by bark beetles
x = Log missed at mill.